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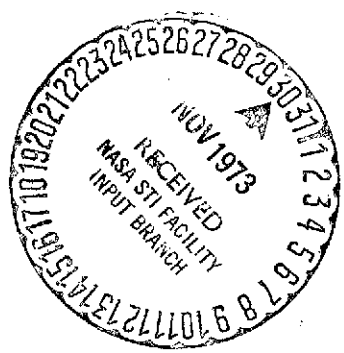

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A BIOLOGIST'S QUESTIONS ON SPACE

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On 31 October 1973 an artificial earth satellite, Cosmos-605, was launched in our country. On board the satellite were laboratory white rats--the classic subjects of medico biological research--stepped tortoises, insects and fungi. The latest part of a broad complex of experiments connected with the solution of tasks of space medicine and biology is being performed. The study of such cardinal questions of biological science as the role of gravity in the functioning of living systems, the origin and nature of the biological rhythms of vital activity, biomagnetism and so forth is envisaged.

It is well known that the world's first manned space flight by Yu. A. Gagarin was preceded by numerous biological experiments involving balloons, rockets and artificial earth satellites. It was essential to verify the ability of highly organized living organisms to withstand the influences which occur during the liftoff, orbital flight, descent, and landing of flight apparatuses, and also to test the functioning of life-support systems. This research proved the possibility of manned space flight, as was also confirmed by trips by cosmonauts within the confines of inner space.

At the same time many new problems arose then, among which the most complex proved to be the adaptation of living organisms to conditions of weightlessness. It was established that weightlessness leads to a redistribution of blood in the organism, a certain loss of condition [detrenirovannost] of the cardiovascular system, increases the excretion of liquids and calcium salts from the organism, and causes moderate atrophy of the skeletal muscles. In fecund flies and the cells of germinating seeds of certain plants, a change was detected in the functional characteristics of the genetic apparatus and in the sensitivity to ionizing radiation and so forth. The mechanism of such changes and the possibility of their progression as the duration of flights increases, is still not clear.

In this connection the probability cannot be ruled out that in manned space flights of long duration (lasting months or years) disturbances might arise which at the moment are difficult, and in a number of instances, impossible, to predict. They can go undetected in manned flights at the present stage of the development of cosmonautics. True, during the 24-day space flight by the cosmonauts in the world's first Salyut orbital station, and also during the 28-day and 59-day flights by cosmonauts on board the Skylab orbital laboratory, their physical and mental condition was good. Nevertheless, the scientific data obtained as a result indicate that further comprehensive and detailed study of the question of the possible duration of manned space flights is essential.

This is also attested by the results of the international astronautical congress that took place recently in Baku. The factual data accumulated by space biology and medicine are still not sufficient for formulating, on their basis, strictly scientifically substantiated recommendations on medicobiological safeguards for space flights of long duration and for answering a number of important practical questions. In particular, it is a question of the time taken for man's adaptation to conditions of weightlessness and for his subsequent readaptation to terrestrial gravity, of the maximum time that a person can remain in a state of weightlessness without endangering his health, and of ways and means of maintaining a definite standard of the functional condition of

a person's organism during prolonged flights. Nor is it clear how essential and expedient it is to create artificial gravity in flights of long duration and what might be the long-term consequences of prolonged flights, including consequences conditioned by the simultaneous influence of weightlessness and penetrating (ionizing) radiation.

Measures for medico-biological safeguards in manned space flights lasting many months will prove to be far from complete if the delicate mechanism of the development of any given changes in the organism caused by conditions of weightlessness are not studied and if the specific features of the influence upon the organism of each of the factors of space flight are not taken into consideration. Such research is only possible in experiments on animals and other biological subjects.

To date, in the USSR and the United States, research has been carried out in space flights on more than 50 types of biological subjects, from viruses to mammals. Study of the effects of weightlessness, of penetrating radiation, and the results of their joint influence remained the main direction of research.

In biological research in space flights, considerable attention is being paid to the problem of radiation safety. It is well known that radiobiological effects depend not only on the physical peculiarities of the radiation but also on the functional condition of the organism being studied, both during and after the influence of radiation. All this has provided grounds for surmising that even nonradiation factors of space flight which have an influence, as is known, on the functional condition of the organism, can considerably change the effectiveness of the action of ionizing radiation. While the combined influence on the organism of radiation and of such flight factors as vibration, overloading and hypokinesia (inadequate muscular activity) can be studied in detail under terrestrial conditions, it is only possible to study the influence of weightlessness on radiation sensitivity and the distinctive features of the formation of injury caused by radiation in experiments performed directly in a space flight. Naturally, such experiments cannot be performed on people. The use of diverse biological subjects makes it possible to detect the basic law-governed patterns of the biological action of radiation and to form a judgement, on the basis of these, about man's possible reactions.

The irradiation of biological subjects in such experiments is carried out before the flight, during the flight, and in the postflight period. For the purpose of studying the distinctive features of the formation of radiation injury under conditions of a space flight, Soviet scientists exposed irradiated samples of yeasts, the seeds of various plants and onion bulbs on the Vostok-5 spacecraft, the Cosmos-110 satellites, and others. U.S. scientists have performed a large series of radiobiological research on the Bios-2 biological satellite.

From the viewpoint of the interests of space medicine and biology, experiments with the artificial irradiation of mammals in flight are of great practical significance. Experiments with irradiation and also research connected with the study of the influence of the factors of flight on internal cellular processes will be of exceptionally great significance for man's successful conquest of space. Thus, whereas it is possible to attempt to normalize functional changes in certain systems of the organism by such means as physical loading and special suits, the disruption of intimate processes of the metabolism at the subcellular and cellular levels, and also any substantial changes of the delicate structures of cells and cell communities in the organism may require the creation of artificial gravity during prolonged space flights. This is conditioned by the fact that modern biology and medicine have still not found sophisticated means and methods of controlling intracellular processes in the organism.

Research into the influence of flight factors upon the heredity of organisms is unique and is not being reproduced on man. Many of the experimental animals not only pass through various stages of their development under conditions of space flight, but also produce offspring. Insofar as the structure of the apparatus of heredity is universal for every living thing on earth, the study of genetic changes in various biological subjects makes it possible to obtain information that is of importance for man's further development of space.

Biological experiments in space are carried out in both unmanned and manned flight apparatuses. Naturally, specialized biological satellites are of the greatest value for the needs of space biology. At the present time a fully automated experiment with animals is being conducted on the latest biological satellite, Cosmos-605. The experimental animals and biological subjects have been selected in the particular quantities calculated necessary to obtain statistically reliable data about the influence of spaceflight factors, above all weightlessness, on the structure and functions of the organism.

It is important to investigate what functions and processes at the cellular level of the organization of living systems are particularly sensitive to the action of weightlessness and space radiation, and how substantial an effect these can have on the functioning of the organism as a whole. Study of the condition of the physiological systems that insure the organism's adaptation to changing conditions of the environment also merits serious attention. It is primarily a question of the nervous system, the endocrine glands and so forth. Research into cardiovascular and muscle systems, whose functioning is linked with the force of gravity to a significant degree, is also of great interest. With the aid of special recording elements--sensors implanted in the brains of rats prior to flight--it is proposed to study the influence of high-energy particles of galactic cosmic radiation, on nerve cells. The results obtained will substantially broaden and deepen our knowledge about the mechanism by which living organisms adapt to space conditions.

The condition of the animals flying in this satellite is being assessed from their motor activity. A special electronic measuring system has been created which makes it possible to register the animal's movements in its cage, accumulate the data, and summarize the motor activity through given intervals of time. Information about this, just as information about the functioning of important elements of the life-support system and of the condition of the environment within the cabin of the satellite, is transmitted to earth with the aid of a **radiotelemetry** system and is processed in the coordination and computing center.

The results of the research on the Cosmos-605 satellite will make a substantial contribution to the development of space medicine and biology. They will contribute to the elucidation of the general biological law-governed patterns which lie at the basis of the vital activity of organisms.